7 Species Problem


- What is a species1?

- Morphological species concept (MSC)
  - The MSC classifies organisms into species based on their morphology. Individuals in the same species are similar to one another in morphology. Individuals in different species are different in morphology.
  - The Linnaean system of classification and most traditional methods of classification use the MSC.
  - The MSC emphasizes morphology rather than behavior in part because classification was and still is often done with preserved specimens or fossils.
  - One problem with the MSC is that it is difficult to say what differences in morphology are important for distinguishing species and how different two groups organisms have to be in order for them to be classified as different species. Some species are polymorphic, but the traits that are polymorphic are not used to distinguish species. Males and females of sexually dimorphic species may be very different from each other, as in the birds of paradise, yet they are classified as members of the same species.
  - In practice, the application of the MSC to a group of organisms takes experience and practice.
  - In some species, it is difficult even for specialists to know whether a group is a single polymorphic species or several separate species. Adults of the tropical butterfly, Astraptes fulgerator, are monomorphic but the larvae are polymorphic.

- The biological species concept (BSC)
  - The BSC groups organisms into species that are reproductively isolated from one another, meaning that members of different species do not interbreed under natural conditions or, if they do, they do not produce viable or completely fertile offspring.

- The BSC is regarded as the correct definition of a species
  - The BSC fits well with the idea that species rather than individuals evolve. If members of the same species freely interbreed, then they are part of the same evolutionary unit. Different species evolve independently of one another.
  - If two groups are known to interbreed, then they will be classified as one species regardless of any differences in morphology. If two groups do not interbreed under natural conditions, then they classified as two species regardless of how similar they are in morphology.
  - In a single geographic location, the MSC and BSC usually distinguish the same species. Native New Guineans distinguish the same species of birds of paradise as European ornithologists. Sometimes, close observation will allow splitting of what was thought to be a single species into two or more species.

- 1 Species definitions other than the MSC and BSC will not be covered.
Even though the BSC is preferred, it cannot always be used in practice.

- For organisms that live in different geographic areas or that are known only from preserved specimens or fossils, it is impossible to know whether interbreeding would occur if the two groups were sympatric. In that case, the extent of morphological variation between sympatric species in the same group is used as a guide to determine whether groups in different areas are species, subspecies, geographic races. It is ultimately a subjective judgment and, as in most such situations, people defend vigorously their own opinions.

Classification of species can change if new information is obtained.

- _Ensatina_ salamanders provide an example of the problem of defining species in practice. If the intermediate forms were not known, the groups at the ends of the range would appear to be good species.
- At one time, five species of baboon in the genus _Papio_ were recognized, _P. anubis_, _P. cynocephalus_, _P. papio_, _P. ursinus_ and _P. hamadryas_. Recent field studies showed that these species interbreed and produce viable hybrids when they are sympatric. They are now classified as subspecies of the single species _P. hamadryas_, for example, _P. h. anubis_ and _P. h. hamadryas_.
- The application of new genetic methods may help determine whether individuals that appear similar are really members of the same species. Differences in the DNA sequence show that _Astraptes fulgerator_ is actually made up of at least 10 different species.

Species definitions are important for practical purposes.

- The Endangered Species Act (ESA) of 1973 provided legal protection of species designated as endangered. One recent example of the use of the ESA is the case of Baker’s larkspur, _Delphinium bakeri_, a species found only near Marshal (on Tomales Bay). The ESA was used as a basis for efforts to block development that threatened the habitat of _D. bakeri_. If _D. bakeri_ were a local population of a common species, the ESA could not be used in this way.
- Conservation biologists have tried to reduce the importance of designating a group as a separate species by arguing that an isolated and distinctive population is an Evolutionarily Significant Unit and deserves legal protection whether or not is classified as a species.

Reproductive isolating mechanisms

Prezygotic barriers

- Anything that prevents mating and fertilization is a prezygotic mechanism.
- Habitat isolation, behavioral isolation, temporal isolation, mechanical isolation and gametic isolation are all examples of prezygotic isolating mechanisms. Some species of fruit flies in the genus _Rhagoletis_ provide an example of habitat and behavioral isolating mechanisms. Different species are reproductively isolated because each species lays its eggs on different host species. Adults return to lay eggs on the hosts from which they emerged. Some species of fruit flies in the genus _Drosophila_ are reproductively isolated because of mechanical incompatibility of their genitalia.

Postzygotic barriers

- Postzygotic barriers prevent a hybrid zygote from developing into a viable, fertile adult. The mule is a typical example.
- Hybrid viability, hybrid fertility or reduced viability or fertility of hybrid offspring all are evidence of postzygotic reproductive isolation. Differences in chromosome number or arrangement of genes on chromosomes usually result in postzygotic isolation because chromosomes may not pair normally during mitosis or meiosis.

❖ Questions (correct answer is underlined)

- **Fruit flies in the genus Rhagoletis have evolved host races each of which live on only one species of fruit true. Specialization to one host is an example of**
  a. Postzygotic reproductive isolation
  b. Prezygotic reproductive isolation
  c. The morphological species concept.
  d. Allopolyploidy.
  e. Exaptation.

- **When classifying species known only from fossils, why can the biological species concept not be used?**
  a. Colors in fossils cannot be distinguished.
  b. Fossil specimens may have been alive at different times.
  c. DNA cannot be extracted from most fossils.
  d. It is not possible to determine which groups were reproductively isolated.
  e. The fossil record is poor and incomplete, making it unlikely that all species are represented by fossils.

- **What type of evidence would be best able to demonstrate that Baker’s larkspur, Delphinium bakeri, is a separate species instead of a slightly different form of a widespread species?**
  a. Baker’s larkspur has flowers that differ in color from those of related species.
  b. Drawings made by early settlers in California show that Baker’s larkspur once had a much larger geographic range.
  c. Baker’s larkspur plants cannot be hybridized to plants from other geographic areas.
  d. Individual plants of Baker’s larkspur are taller on average than related species found in the same area.
  e. None of the above.